

forming a via in said upper insulating layer to expose a top surface of said upper barrier layer;

forming an upper Cu metal layer over said upper insulating layer and in said via to make electrical contact with said upper barrier layer; and

planarizing a top surface of said upper Cu metal layer and a top surface of said upper insulating layer.

In the Drawings

Red-lined drawing Fig. 2C is attached with correction.

REMARKS IN REGARD TO DRAWINGS/SPECIFICATION

Applicant has amended the specification on page 11, correcting the reference characters in the second full paragraph.

Support for the amendments to the specification may be found in the specification, drawings and claims.

REMARKS IN REGARD TO CLAIM OBJECTIONS

As set forth above, Applicant has amended the claims to particularly point out and distinctly claim the subject matter which Applicant regards as his invention.

REMARKS IN REGARD TO CLAIM REJECTIONS - 35 U.S.C. §112

Applicant has amended claim 6 to contain subject matter as described in the specification. Support can be found for the amendment on page 8, lines 15-16 and page 10, lines 15-16.

REMARKS IN REGARD TO CLAIM REJECTIONS - 35 U.S.C. § 102

The Examiner rejected claims 1, 3-5 and 10 under 35 U.S.C. § 102(e) as being anticipated by Shao et al. (U. S. Patent 6,124,194). Applicant respectfully disagrees.

The Examiner states that, regarding claims 1 and 10, Shao et al. teach and antifuse comprising: a lower insulating layer, a lower Cu metal layer; a lower barrier layer; an antifuse material layer; an upper barrier layer; an upper insulating layer; and an upper Cu metal layer. However, the antifuses as taught by Shao et al. and Applicant are very distinct. Thus, as set forth in greater detail below, Applicant's claims are not anticipated by Shao et al.

FIG. 1 of Applicant's application shows the antifuse 10 of the present invention. Antifuse 10 of the present invention is designed to have a small capacitance. Capacitance in antifuse technology is a function of the area of the metal in the antifuse. The smaller the area, the smaller the capacitance.

Antifuse 10 of the present invention connects a bottom Cu metal line (14) to a metal line (not shown) above via 42. TaN metal layer 30 is encapsulated by lining layer 20. TaN metal layer is formed by etching a hole into barrier layer 28, overfilling the hole with TaN metal and then polishing off the excess TaN metal. The reason behind forming the antifuse in this manner is to provide the smallest area metal layer and to make sure the TaN metal layer is encladded in barrier 28.

A layer of antifuse material 34 is disposed over lower barrier metal layer. Upper barrier metal layer 36 is disposed over the antifuse layer 34. Antifuse 10 of the present invention is located between via 42 and Cu metal layer and has a very small capacitance driven by the relatively narrow thickness of the antifuse and the small area of the antifuse.

In contrast, Shao et al. discloses a *method* of fabricating an antifuse integrated with a dual damscene process. Shao et al. discloses an antifuse 16 having a metal line 12 and a first metal via 14. Antifuse metal layer 36 is disposed *atop* metal via 26. Antifuse

metal layer 36 is not formed in the same manner as Applicant's. First, metal layer 36 has a much greater area than Applicant's antifuse as known to those skilled in the art. Second, metal layer 36 stretches much wider than via deposit 26 and overlaps the outside of the via and SiN layer 28. Thus, it is not formed as Applicant's antifuse. Also, Applicant's antifuse is formed at the bottom of via 42, not on top of a via as in Shao et al. Applicant's antifuse is directly in contact with the bottom metal line 14 whereas in Shao et al., the antifuse sits on top of a via and is in contact with the upper metal line.

Shao et al. disclose a parallel-plate, large area antifuse with a full stack. Applicants disclose a half stack, small bottom plate antifuse processed independently of metal layer 30. Metal layer 30 is a shallow bottom electrode. Applicant's antifuse has a small capacitance and is processed differently than Shao et al. In addition, because of the smaller area, the antifuse has a smaller capacitance and smaller leakage both of which are a function of the area and the different position and design of the antifuse.

If a prior art reference cited as anticipating a claimed invention is shown to lack a characteristic of the claimed invention, that proof negates the assertion that the claimed invention was described in the prior art. In re Mills, 16 USPQ2d 1430, 1432 (Fed. Cir. 1990). Thus, claims 1 and 10 are not anticipated by Shao et al.

If the prior art reference lacks a characteristic of the claimed invention and that proof negates the assertion that any independent claim was described in the prior art, then any dependent claim cannot be anticipated by the same prior art reference. Thus, claims 3, 4 and 5 cannot be anticipated by Shao et al.

REMARKS IN REGARD TO CLAIM REJECTIONS - 35 U.S.C. § 103

The Examiner states that claims 2 and 6-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shao et al. in view of Yeouchung et al. (U.S. Patent 6,001,693). Applicant respectfully disagrees.

The Examiner states that regarding claim 2, Shao et al. teach a first and a second cap but Shao et al. fail to teach that the second cap layer envelopes the antifuse material and the upper barrier layer. The Examiner states that Yeouchung et al. teach that is well known in the art to envelope the antifuse material and the upper barrier layer with a cap layer and therefore it would have been obvious to modify Shao et al. to include the limitation of enveloping the antifuse material and the upper barrier layer with a second cap layer. However, the Examiner has failed to address all limitations in claim 2 and as such, claim 2 is not obvious.

Claim 2 is set forth as follows:

2. The metal to metal antifuse of claim 1 further including:

a first cap layer disposed over said lower Cu metal layer and the top surface of said lower insulating layer, said first cap layer having a first-cap-layer via formed therethrough exposing a top surface of said lower Cu metal layer. wherein said lower barrier layer is disposed in said first-cap-layer via in electrical contact with said lower Cu metal layer; and

a second cap layer enveloping said antifuse material layer and said upper barrier layer, said second cap layer having a second-cap-layer via formed therethrough exposing a top surface of said upper barrier layer, wherein said upper Cu metal layer is disposed in said second-cap-layer via.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest *all the claim limitations*. MPEP § 2142 (emphasis added). Here, the references when combined do not teach or suggest all the claim limitations.

Neither Shao et al. nor Yeouchung et al. teach "said first cap layer having a via formed therethrough exposing said top surface of said lower Cu metal layer, wherein

said lower barrier layer is disposed in said first-cap-layer via in electrical contact with said lower Cu metal layer." In other words, it is not taught that the lower barrier metal layer is in electrical contact with said Cu metal layer. "The prior art references must teach or suggest all the claim limitations." MPEP § 2142; *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). "All words in a claim must be considered in judging the patentability of that claim against the prior art." MPEP § 2143.03; *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). Thus, claim 2 is not obvious over Shao in light of Yeouchung.

As to claims 6 through 9, they all depend on claim 2. If an independent claim is found to be non-obvious, all claims depending therefrom are non-obvious.

CONCLUSION

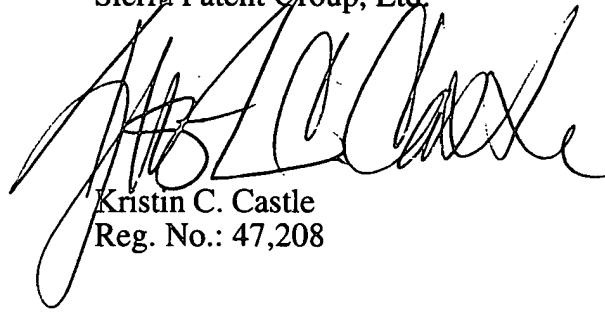
For the foregoing reasons, Applicants submit that all of the claims in this application, claims 1 through 10, are in condition for allowance and Applicants respectfully request reexamination of the present application, reconsideration and withdrawal of the present rejections. Should there be any further matter requiring consideration, the Examiner is invited to contact the undersigned counsel.

For these reasons, and in view of the above amendments, this application is now considered to be in condition for allowance and such action is earnestly solicited.

Respectfully Submitted,
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